Variations in eruptive activity at Mount Etna in 2007-2009: pattern classification of volcanic tremor data reveals state transitions

B. Behncke, S. Falsaperla, H. Langer, A. Messina, S. Spampinato
Ingv-Catania, Piazza Roma 2, 95125 Catania

Eruptive activity at Mount Etna in 2007-2009 consisted of 7 episodes of lava fountaining and periodic Strombolian activity at the summit, followed by an eruption on the upper east flank that started on 13 May 2008 and is continuing as of May 2009, making this the longest-lasting flank eruption of the volcano since 1993. The lava fountains originated from the Southeast Crater, the youngest of Etna's four summit craters; four occurred from the summit vent of the crater between late-March and early-May 2007, whereas the remaining three, on 4-5 September, 23-24 November 2007 and 10 May 2008, occurred from a new vent on its lower eastern flank of the Southeast Crater cone. The latter three episodes lasted 10, 6 and 4 hours, respectively, and thus were much longer than most other paroxysms at Etna in the past few decades. The 10 May 2008 episode produced some of the longest lava flows (6.2 km) ever erupted from an Etnean summit vent, and had this episode lasted much longer, the lava might have approached close to populated areas (Milo, Zafferana Etnea). Volcanic tremor data recorded during the same period by the seismic network of the Istituto Nazionale di Geofisica e Vulcanologia (Sezione di Catania) show significant variations related to the changes in the eruptive activity.

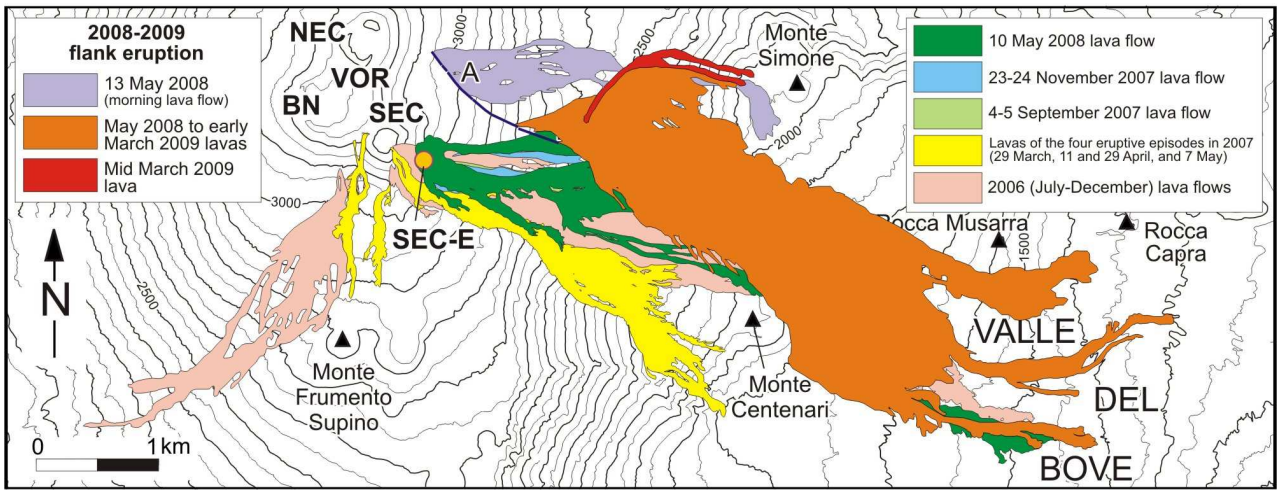

Fig. 1. Map of lava flows erupted from the Southeast Crater at the summit of Etna during the seven lava fountaining episodes between 29 March 2007 and 10 May 2008, and during the 2008-2009 E flank eruption (updated as of early March 2009).

Application of a new, autonomously working software, which combines various methods of pattern classification based on unsupervised learning, is used to detect state transitions in the volcanic tremor data. We investigate changes in seismic radiation and focus on transitions from pre-eruptive to eruptive activity during summit and flank eruptive episodes, taking into account field and other (geological and petrological) observations. The conspicuous eruptive events of 2007-2008 are compared to more recent time windows, falling into the period of continued low-level flank lava effusion accompanied by occasional mild Strombolian activity.

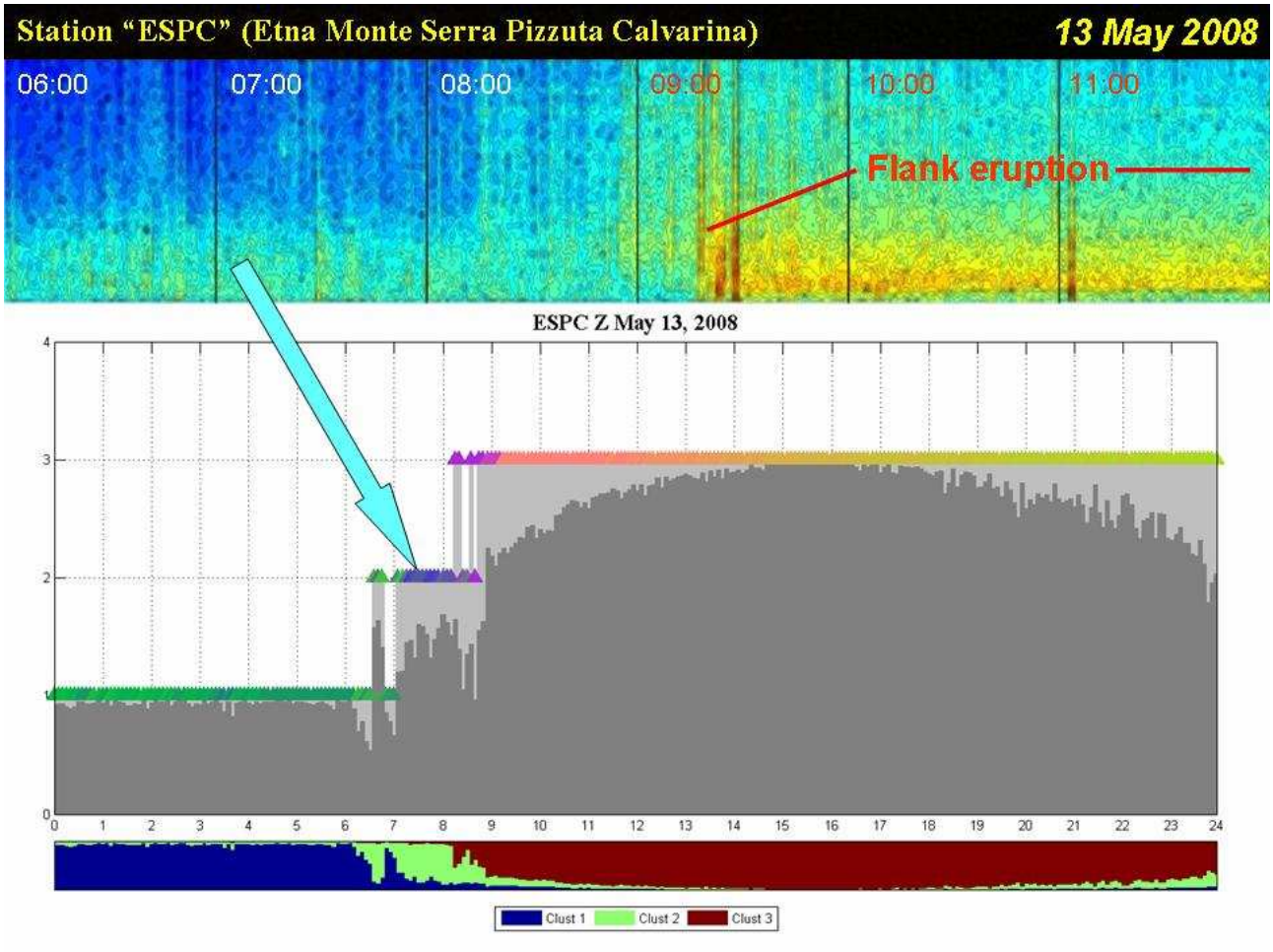

Fig. 2. Comparison of spectrogram recorded by seismic station "ESPC" on Etna's south flank at the onset of the flank eruption on 13 May 2008, with Kohonen map diagram (center) and fuzzy cluster membership (bottom). Arrow links same time in spectrogram and lower diagram, showing early recognition of a significant state transition nearly two hours before a visible change is evident in the spectrogram.